

## PLASTICATING CONTROL APPARATUS FOR INJECTION MACHINE

### BACKGROUND OF THE INVENTION

The present invention relates to a plasticating control apparatus for controlling plasticating conditions to stabilize the temperature of a material to be plasticated, and molten and kneading states thereof in an injection machine.

Unlike an extrusion machine wherein a screw in a barrel (i.e., a heating cylinder) is continuously rotated, a screw in an in-line screw type injection machine periodically repeats rotation and stopping in accordance with a plasticating measuring operation and an injection action. During the plasticating process, since the screw is moved backward while a material, such as a molten resin, is being fed from a hopper, the effective length of the screw constantly changes. The temperature of the molten resin and the molten and kneading states thereof become nonuniform due to the basic operations described above, resulting in degradation of quality of finished products. In order to prevent this, conventionally, plasticating control is performed by controlling a backward movement speed of the screw during the plasticating process in the injection machine. In order to control the backward movement speed of the screw, various control apparatuses have been conventionally proposed wherein a rotational speed of the screw is adjusted to control the action of the molten resin fed in front of the screw, and simultaneously or independently, a back pressure of a hydraulic cylinder is adjusted to control the backward resistive force of the screw.

However, the backward resistive force is a sum of the back pressure of the hydraulic cylinder, a frictional force between the screw and the heating cylinder, a frictional force between the molten resin in the screw channel and the heating cylinder, a packing resistance in the hydraulic cylinder, and a sliding resistive force of a hydraulic motor unit. These forces interfere with the backward movement of the screw. The molten resin pressure must be equal to or higher than the backward resistive force. Even if the back pressure becomes zero, the molten resin pressure cannot be zero but has a given value. Therefore, when only the back pressure is controlled, plastication cannot be performed at a molten resin pressure lower than the back pressure. For example, when plasticating control is improper under the condition where the molten resin pressure is near zero, the backward movement of the screw is pulsated or the backward speed is locally decreased. In a worst case, depending upon the type of resin, the screw is stopped.

Furthermore, since the screw back pressure adjustment indirectly controls the backward speed of the screw, the adjustment itself is very difficult. Even if the back pressure of the screw is controlled, a time lag occurs in a hydraulic piping system due to changes in volumes caused by expansion/contraction of a working fluid and changes in pressures of the hydraulic piping system. The molten resin pressure cannot be immediately controlled, resulting in inconvenience. Furthermore, it is very difficult to control the backward resistive force depending upon the molding conditions and the type of resin supplied to a general-purpose screw.

### SUMMARY OF THE INVENTION

It is, therefore, a principal object of the present invention to provide a plasticating control apparatus for an injection machine, wherein a backward speed of a screw can be controlled with high precision in a wide range varying from zero molten resin pressure.

It is another object of the present invention to provide a highly responsive plasticating control apparatus wherein a time lag caused by a hydraulic piping system can be eliminated.

It is still another object of the present invention to provide a simple plasticating control apparatus which can be easily applied in a conventional general-purpose injection machine.

In order to achieve the above objects of the present invention, there is provided a plasticating control apparatus for an in-line screw type injection machine, which includes a resin pressure sensor for detecting as an electrical signal a pressure of a molten material at a distal end of a heating cylinder during plastication; an electric motor whose rotational speed is controlled in response to a control signal; means for directly converting the rotational speed of the electric motor to reciprocal movement of a hydraulic piston for driving a screw; and a control circuit for receiving the electrical signal from the resin pressure sensor and supplying the control signal to the electric motor in accordance with the electrical signal, the control signal supplied from the control circuit to the electric motor being adapted to control the rotational speed of the electric motor and hence a backward speed of the screw such that the pressure of the molten material at the distal end of the heating cylinder is not a negative pressure but substantially zero kg/cm<sup>2</sup>.

According to the plasticating control apparatus having the arrangement described above, when the screw is moved backward during plastication measurement, the electric motor can immediately respond to the control signal supplied from the control circuit. The rotation of the motor can be accurately transmitted to the hydraulic piston to smoothly move the screw backward, and the screw is free from the effects of slight hydraulic pressure changes and pulsation, an operation lag caused by compression of the working oil, and a resin pressure.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram showing a plasticating control apparatus for an injection machine according to an embodiment of the present invention;

FIGS. 2 to 5 are, respectively, graphs for explaining differences between the operations of the apparatus of the present invention and the conventional apparatus; and

FIGS. 6 and 7 are respectively horizontal and vertical sectional views showing a coupling structure between an electric motor and a piston rod according to another embodiment of the present invention.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A plasticating control apparatus for an in-line screw type injection machine according to an embodiment of the present invention will be described with reference to the accompanying drawings.

FIG. 1 shows the overall configuration of the in-line screw type injection machine according to the present invention. The solid line represents a hydraulic system,